Fig. 3. *Periplaneta americana*, p. 935. 4-jointed reproduction form of tarsus (from third pair of legs). × 8.
4. *Stylopyga orientalis*, p. 939. Malformed tarsus, 3rd pair, nymph. a^{i}, a^{iii}, incomplete articulations; a^{ii}, a^{iv}, complete articulations.
5. ,, ,, Malformed tarsus, 3rd pair, nymph. a^{i}, a^{iii}, complete articulations; a^{ii}, incomplete articulation.
6. ,, ,, Malformed tarsus, 3rd pair, ♀ adult.
7. ,, ,, Malformed tarsus, 1st pair, nymph.
8. ,, ,, Malformed tarsus, 1st pair, ♂ adult.
9. ,, ,, Malformed tarsus, 2nd pair, ♀ adult.
10. ,, ,, Malformed tarsus, 2nd pair, nymph.

[Figs. 4 to 10 are not to uniform scale.]

2. Contributions to the Osteology of Birds. Part II. *Impennes*[1]. By W. P. Pycraft, A.L.S.

[Received October 24, 1898.]

(Plates LIX.–LXI.)

Contents.

i. Introductory Remarks.

The Impennes represent one of the most sharply defined groups to be found amongst the Carinatæ. The skeleton presents many features which are quite unique. This is particularly the case with regard to the shoulder-girdle and pectoral limb, which have become considerably modified in adaptation to new functions—the use of the fore limb as a paddle instead of as an instrument of flight. The pectoral limb, shoulder and pelvic girdles have departed furthest from the typical Avian form; they represent the high-water mark of skeletal specialization which has been attained by the group, whilst the skull, pes, and thoracic vertebræ represent the least specialized and most primitive portions of the skeleton; but they do not furnish us with any facts of very great importance, they do not carry us beyond the confines of the Class. Osteologically the Penguins seem to be most nearly related to the Tubinares and Pygopodes, and, as Dr. Gadow and others have shown, the evidence of the soft parts confirms this supposition.

[1] For Part I., see P. Z. S. 1898, p. 82.

So much is known already about the osteology of the Penguins, thanks to the admirable memoirs of Watson (**18**) and Menzbier (**13**), that it will not be necessary to describe the bones in any great detail; rather, it will be the aim of the present paper to serve as a supplement to those just mentioned.

ii. The Skull of the Adult.

The skull of the Impennes presents many points in common both with the Pygopodes and the Tubinares, but it can nevertheless be readily distinguished from that of both of these groups.

The Occipital Region.—The occipital condyle is sessile, and scarcely projects beyond the rim of the foramen magnum. In *Aptenodytes* there is a slight tendency towards a pedunculate condition. The general form of the condyle is reniform: in young specimens traces of the notochord are found in the shape of a small median dimple.

The foramen magnum is almost circular, but varies slightly in outline. The plane of the foramen slopes obliquely backwards. Its superior boundary forms the free edge of a well-rounded concavo-convex supra-occipital—the convexity outwards—which forms the characteristic "cerebellar dome." On either side of this dome lie two bony "wings" or plates which present two distinct types of arrangement. These plates are formed, in part by the squamosal, and in part by the parietal bones (see page 968).

In *Catarrhactes*, the first of the two types, these plates arise from the squamosal prominence and run upwards to terminate on the lateral region of the cerebral dome, and are thus separated one from another by nearly the whole width of the skull.

Spheniscus forms the second type. Arising in the same region as the above, these plates have become thrust back, as it were, from the cerebral on to the cerebellar dome, thus placing a wide, deep, space between them and the cerebral dome. This space represents the posterior portion of the temporal fossa, which lodges the temporal muscle. The plate is continued upwards to the vertex of the skull, where, as in *S. magellanicus*, it joins a median sagittal crest bridging the space from the cerebral backwards to the cerebellar dome.

All the genera but *Spheniscus* belong to the first type. In *C. chrysocome* the cerebellar dome is rather more sharply defined than in any other members of the genus. In *C. chrysocome* and *C. chrysolophus*, seen in profile, its dorsal moiety appears slightly depressed; it passes, on either side, almost insensibly into the cerebral dome. In *C. schlegeli* and *Megadyptes antipodum* the cerebellar arises almost abruptly from the cerebral dome, and its greatest curve is in the centre of the median line, projecting appreciably beyond the level of the foramen magnum. The squamoso-parietal wings of *C. chrysocome* and *C. chrysolophus* are hardly to be distinguished; their greatest lateral expansion does not exceed ·2 in. and the intervening fossa is narrow; in *C. schlegeli*, the lateral expansion of the wing is ·3 in. and the fossa is wider than that in the two preceding forms. In *Megadyptes antipodum* this region of the fossa is both deep and wide, and the squamoso-parietal wings are well developed, making this region of the skull closely resemble that of *Eudyptula* (Pl. LX. fig. 5).

Pygoscelis resembles *Catarrhactes* in the formation of this region of the skull. In the shape of the cerebellar dome, in its greater width and curvature in profile, it approaches *C. schlegeli*. The squamoso-parietal wings are but feebly developed, being represented only by a low ridge. *P. adeliæ* differs from *P. papua* in the outline of the cerebellar dome, inasmuch as in the latter the curve continually increases till it ceases at the foramen magnum.

In *Aptenodytes* the squamoso-parietal wings are more feebly developed even than in *Pygoscelis*. In *A. forsteri* they scarcely extend halfway to the lambdoidal ridge.

Eudyptula, in the form of the cerebellar dome, is somewhat intermediate between *C. chrysocome* and *C. chrysolophus*. In the development of the squamoso-parietal wings, and the width of the fossa posteriorly, it surpasses both. Though the vertical height in both genera is relatively the same, in *Eudyptula* the wings are further removed from the cerebral dome; in *E. minor* they are bent forward superiorly so as to join this almost at a right angle. In *E. albosignata* they run up to join the supra-occipital or lambdoidal ridge—which lies, really, halfway between the suture of that name and the coronal suture—where they remain separated by some ·6 in.

Spheniscus demersus differs from *S. magellanicus* in that the temporal fossa, posteriorly, does not actually reach the vertex of the skull: the squamoso-parietal wings are continued from the top of the fossa forwards as a narrow and low ridge, eventually joining a median sagittal crest running forwards on to the cerebral dome. In *S. magellanicus* this region of the fossa runs upwards to the vertex, terminating at the sagittal ridge, being accompanied throughout by the squamoso-parietal wings.

In all the genera the exoccipitals are produced downwards, on either side, into a short, blunt, paroccipital process. The free edge of this, in *Catarrhactes*, is longer than that of the squamosal prominence; in *Pygoscelis* these relations are reversed. In *Aptenodytes*, *Eudyptula*, and *Spheniscus* these processes are subequal. The paroccipital processes form the outer walls of a large *pneumatic* cavity lying between the proötic and exoccipital, which opens into the mouth of the tympanic cavity.

In the skull of the nestling *Spheniscus* the form and position of the squamoso-parietal wings closely resemble those of *Catarrhactes*. The posterior region of the temporal fossa, so remarkable for its depth and width in the adult, is in the young bird very shallow and widely separated from its fellow of the opposite side.

The Roof of the Skull.—This is formed by the frontal and parietal bones. The posterior region of the cranium, in all the *Sphenisci*, is crossed transversely by a ridge of bone. In *Catarrhactes*, *Pygoscelis*, *Aptenodytes*, and *Eudyptula* this ridge traverses the region of the lambdoidal suture, and may be called the lambdoidal ridge. In the adult it forms a line roughly dividing the cerebellar from the cerebral dome. In *Spheniscus* the ridge traverses the region of the coronal suture, and may be called the coronal ridge. In young birds both a lambdoidal and a coronal ridge exist together for a short time; later, by the deepening of the temporal fossa posteriorly, the latter becomes the free edge of the squamoso-parietal wing.

The *supra-orbital region* of the cranial roof presents some important modifications. In all, the frontal is more or less deeply grooved for the nasal gland, the groove running the whole length of the frontal from the parietal forwards to the level of the posterior border of the nasal, and it is with the form and development of this that we have now to deal. In *Aptenodytes* (Pl. LIX. fig. 3) the free edge of this groove is reflected up and runs forwards as a narrow tapering supra-orbital ledge for the whole length of the groove. In *Eudyptula* (Pl. LIX. fig. 4) and *Spheniscus magellanicus* (Pl. LIX. fig. 1) this ledge disappears almost immediately after its origin. In *Spheniscus demersus* the ledge takes the form of a very broad lateral expansion abruptly truncated in front, in the region of the posterior third of the groove. In *Catarrhactes* (Pl. LIX. fig. 5) and *Pygoscelis* (Pl. LIX. fig. 2) this ledge has greatly increased in width, and runs forwards to within a short distance of the lachrymal: moreover, its free edge has become flattened dorsally into a very distinct rim. This reaches its greatest development in *Pygoscelis papua* (Pl. LIX. fig. 2). In all, the supra-orbital groove is more or less completely walled in by a ridge of bone posteriorly. In *P. adeliæ* this wall is absent.

The *interorbital region* of the frontal varies in width, from a broad median strip of bone in *Aptenodytes* to a sharp ridge in *P. adeliæ*.

The outline of the supra-orbital ledge is continued forwards by the lachrymal. In *Catarrhactes chrysocome* (Pl. LIX. fig. 5) and *Pygoscelis tæniata* this latter is largely visible in a dorsal view. Less of it is seen in *C. chrysolophus*, *Aptenodytes*, *Eudyptula*, and *Pygoscelis papua* (Pl. LIX. fig. 2). It is largely visible in *P. adeliæ*, and has quite disappeared beneath the nasal in *Spheniscus*.

The posterior ends of the nasals are not distinguishable in the adult Penguin. The extreme posterior ends of the nasal process of the premaxilla can apparently always be made out lying between the nasals, except in very old specimens of *Spheniscus demersus*, where they are indistinguishable. In *Aptenodytes* and *Pygoscelis* the two prongs of this region of the premaxilla remain distinct one from another and from the nasals throughout life (Pl. LIX. figs. 2 & 3).

The Basioccipital Region.—When seen from below, this is bounded in the adult, on all sides, by a raised bony wall. Behind lies the occipital condyle, laterad of this a pair of mammillary processes, furnished by the exoccipitals, and immediately in front of these lie two bony ridges converging in the middle line to meet over the parasphenoidal rostrum. In all but *Spheniscus* there is a more or less well-marked precondylar fossa. The two bony ridges (right and left) along the anterior border of this region represent what, earlier in life, formed the free edge of the basitemporal plate of the parasphenoid (p. 970). From the alisphenoid wings of the parasphenoid there has grown downwards a thin plate of bone to fuse with the sometime free edge just referred to. Thus the Eustachian grooves become converted into tubes. On breaking away the wall of this tube, a second smaller tube is found immediately above it. This also is formed in the parasphenoid and lodges the internal carotid artery, on its way to pass into the pituitary fossa. The larger, outer tube opens immediately behind the quadrate and forms the external auditory meatus.

Each mammillary tubercle is separated from the paroccipital process lying behind, and without, by a wide groove, at the bottom of which lie the foramina for the vagus and condyloid nerves.

The *parasphenoidal rostrum* takes the form of a slender curved rod, supporting the presphenoid and mesethmoid, and terminates at a point corresponding with a section through the skull at the lachrymals. Remnants of the anterior and posterior basicranial fontanelles [1] not infrequently occur, the latter being more or less concealed by the basitemporal plate.

The Lateral Aspect of the Cranium (Pl. LX. figs. 1–3).—The *tympanic cavity* is a tubular opening lying behind the articular end of the quadrate; it is bounded behind by the paroccipital process, above by the squamosal prominence, and mesially by the proötic and occipital bones.

The *squamosal prominence* is formed by a lateral outgrowth of the base of the squamosal immediately above its articulation with the quadrate. It forms a sloping floor to the posterior region of the temporal fossa.

The *temporal fossa* can best be understood by a careful study of its form and size in *Catarrhactes* (Pls. LIX., LX. figs. 5 & 2) or *Pygoscelis* (Pl. LIX. fig. 2). In these it is represented by a shallow horseshoe-shaped fossa lying between the postorbital process and the squamoso-parietal wings already described (p. 968). Its outline is defined by a raised surface, representing the extreme limit of attachment of the temporalis muscle; from the postorbital process it sweeps upwards, backwards, and downwards to terminate on the squamosal prominence. The greater part of the fossa rests upon the convex wall of the cerebral dome; posteriorly, from the squamosal prominence to its vertex, it is much deepened. From the apex of its semicircular outline there runs a well-defined

[1] In my paper on the Osteology of the Steganopodes (**15**), in describing the skull of *Fregata*, I mistook this anterior basicranial fontanelle for the Eustachian aperture. The Eustachian tubes in this genus are represented by grooves formed by the free edge of the basitemporal plate. The "traces of the Eustachian tubes" in the skull of *Sula*, referred to in this paper, are, as in the case of *Fregata*, remnants of this embryonic fontanelle.

lambdoidal ridge across the top of the skull to join the apex of the fossa of the opposite side (Pl. LIX. fig. 5, *t.l.r.*). In *Spheniscus* the posterior region of the fossa becomes greatly deepened, and the squamoso-parietal wings appear as though they had been forced backwards on to the cerebellar dome, leaving a deep groove between the base of this and the cerebral dome (Pl. LIX. fig. 1). As already stated, the fossa of one side is separated from that of its fellow on the other by a median, dorsal, sagittal ridge. The lambdoidal ridge of *Catarrhactes* is represented here by the free edge of the huge squamoso-parietal wing: in addition, there exists a second ridge anterior to this—the coronal ridge already described (p. 961), which is connected with the lambdoidal by a median sagittal crest (Pl. LIX. fig. 5, *cor.r.*). These ridges serve for the attachment of the peripheral portion of the temporalis muscle. The squamosal and parietal bones only take part in the formation of the temporal fossæ. The posterior region of the temporal fossa is wider in *C. chrysolophus* than in *C. chrysocome*, that of *C. schlegeli* is wider still. In *Megadyptes antipodum* it reaches its maximum, being both wide and deep, and somewhat closely resembles that of *Eudyptula*. The squamoso-parietal wings on either side are well developed and curve gently backwards, the outline of the free edge corresponding with that of the curve of the cerebral dome.

In *Aptenodytes* this region of the fossa is exceedingly shallow. In *Eudyptula* it is intermediate between the typical *Catarrhactes* and *Spheniscus*; that of *E. albosignata* reaches the lambdoidal ridge, in *E. minor* it falls below this.

The trigeminal foramen lies near the base of the skull, slightly below the level and mesiad of the articular head of the quadrate. Immediately above this, to the inner side of the squamosal prominence, is a tubular recess lying between the proötic and alisphenoid bones, and leading eventually, in the dried skull, into the cranial cavity. This recess is apparently derived by an invagination or ingrowing of the alisphenoidal border of the mouth of a fenestra lying immediately above the trigeminal foramen, with which it may even be confluent, as in the case of a young, macerated skull. It is found also in the skulls of the Tubinares—in some of which it is of great size—and Steganopodes (**15**).

The *orbit* is overarched, behind and above, by the postorbital process and supra-orbital ledge. The latter has already been described (p. 961); the former is made up in part of a lateral expansion of the frontal, and in part by the alisphenoid, to which is added a separate element in the shape of a cartilaginous sphenotic. Later the whole fuses into an indistinguishable outstanding mass—the postorbital process (Pls. LX., LXI. figs. 2 & 3). The inner wall of the orbit is formed for the most part by the orbito-sphenoid, its hinder wall is formed by the alisphenoid. The interorbital septum divides it mesially from the chamber of the opposite side. The septum is formed by the presphenoid and mesethmoid. It is perforated by an interorbital fenestra, the size of which varies with age. The optic foramen is bounded in front by a median bony bar from the presphenoid, in front of which lies the interorbital fenestra.

The *mesethmoid* is a median, vertical, bony plate, in the adult fused with the parasphenoid below and the nasals and frontals above, and merging posteriorly into the orbito-sphenoid. It is greatly thickened anteriorly, and expanded laterally along its dorsal aspect, the lateral expansions curving outwards and downwards to form the "antorbital plate," which encloses a space opening forwards into the lachrymo-nasal fossa. In *Aptenodytes* and *Eudyptula* only, the postero-superior angle of this antorbital plate is perforated for the olfactory nerve; in other cases it runs along inside and above this plate and does not perforate it. There are no turbinal ossifications.

Only in *Aptenodytes* does the upper jaw greatly exceed the cranium in length; for the rest, the length of the upper jaw, from its tip to the ends of the nasal processes, is about equal to the distance from the last point to the cerebellar prominence. In *Catarrhactes* it is stout and somewhat deflected; the nasal processes are more or less swollen, attaining their maximum thickness in *C. schlegeli*, and their minimum in *Megadyptes antipodum*, which closely approaches *Pygoscelis*. In *Pygoscelis* the nasal processes are more or less uniform in thickness throughout. In *P. papua* the upper jaw is about $\frac{1}{5}$ longer than the cranium; in *P. adeliæ* it is much depressed in the middle region, giving the jaw the appearance of being broader across than it really is; its outline in dorsal profile is, from the tip backwards, convex rather than concave as is usual; the length of the whole jaw is somewhat less than that of the cranium. In *Eudyptula* the upper jaw is more slender in proportion to the cranium than in any other genus. In *Spheniscus* the nasal processes of the premaxilla are greatly swollen, and the space enclosed by the internal and external nasal processes tends to become filled up by bone, and an accumulation of bony matter may run forwards from this along the nasal process of the premaxilla, so as ultimately to considerably decrease the size of the external nares.

The *quadrato-jugal bar* in *Aptenodytes*, *Catarrhactes*, and *Pygoscelis* is characterized by a very strongly-marked downward curvature. Descending abruptly from the lachrymal, it straightens out near its middle to run backwards to the quadrate parallel with the long axis of the skull (Pl. LX. figs. 1–3). In *Spheniscus* the curve is comparatively slight, and in *Eudyptula* is barely visible.

The *vomer* is free, double, and blade-shaped. The two halves are fused slightly along the antero-ventral border. It articulates on either side with the anterior end of the palatine, which sends forward a bony spur for its increased support.

The *palatines*, anteriorly, form slender rods, running forwards beneath the maxillo-palatine processes to fuse with the premaxilla and maxilla, anteriorly to these processes. Posteriorly, behind the vomer, the palatines expand into moderately broad plates; the posterior palatine border is more or less emarginate, but its exact outline varies.

The *pterygoids* are expanded distally into broad plates or laminæ, the anterior border of which follows more or less the outline of the posterior margin of the articular end of the palatine. *C. chrysolophus* and *Eudyptula* appear to be exceptions to this rule. Concerning the early history of the pterygoid, see p. 973.

The *quadrate* has distinct otic and squamosal articular heads. The orbital process in *Catarrhactes*, *Eudyptula*, and *Spheniscus* projects from the main body as a somewhat upwardly-curved rod with a sharp superior border; that of *Pygoscelis* closely resembles these but is longer. In *Aptenodytes* it takes on a triangular form, with a thickened inferior border. At the base of the inferior border of the orbital process lies a small well-defined pterapophyseal facet for articulation with the pterygoid. There are two condyles for articulation with the mandible, and these are confluent. The inner has two articular surfaces—an internal lateral facing the median plane, and a ventral which is continued backwards on to the semicircular outer face, immediately above and in front of which lies the deep cup for the articulation of the quadrato-jugal bar.

The Mandible.—The two rami of the mandible are united by a very slender symphysis. There is a short angular and internal angular process. A dentary, angular, supra-angular, and coronoid can always be distinguished. In young birds there is a distinct splenial.

In *Catarrhactes* the posterior border of the dentary is divided into two limbs—a small superior, and a large inferior having a strongly pronounced sinuous border which articulates with the supra-angular, the depth of the jaw in the region of this articulation being very considerable. The deeply incised posterior border of the dentary and the oblique slightly notched border of the supra-angular enclose a lozenge-shaped vacuity which is more or less imperfectly closed from within by the splenial. A second, oval vacuity pierces the supra-angular near its posterior end. Viewed from the inner side, this is seen to lead into an oblong fossa formed by cutting away the superior border of the coronoid; this fossa leads anteriorly into the dental foramen. The mandible of *C. chrysocome* can be distinguished from that of *C. chrysolophus* by the greater convexity of its dorsal border, both dentary and supra-angular having the dorsal border much arched.

In *Pygoscelis* the depth of the jaw in the region of the dentary suture is very much less than in *Catarrhactes*. The superior limb of the dentary suture is relatively longer, and the posterior runs directly backwards with a gentle downward curve. It entirely lacks the strong sinuous border of *Catarrhactes*. The posterior vacuity is largest in *P. antarctica*.

In *Aptenodytes* the jaw is long and slender. The dentary of

A. forsteri has a conspicuous downward curve, that of *A. patagonica* is nearly straight. The posterior dentary border resembles that of *Pygoscelis*. The inferior border of the supra-angular is gently curved, not notched as in *Pygoscelis*. The splenial is long and narrow, and does not close the vacuity left by the excavation of the dentary and supra-angular sutures. The coronoid in *A. patagonica* is short and truncate anteriorly; in *A. forsteri* it is very long and slender, running forwards as far as the middle of the anterior lateral vacuity.

In *Spheniscus* the jaw is deeper from the middle of the supra-angular to the posterior border of the anguiare than in *Pygoscelis*, and the processus angulare is longer. The anterior lateral vacuity is completely closed by the splenial. The coronoid is triangular in form: its inferior border is closely applied to the supero-posterior border of the splenial.

Eudyptula, in the form of the lower jaw, closely resembles *Spheniscus*, but is more slender throughout, and the internal and posterior angular processes are short, rather resembling those of *Pygoscelis*. It can easily be distinguished from *Pygoscelis*, however, by its shorter coronoid.

The Hyoid.—The hyoid of the Penguins resembles that of the Tubinares much more closely than that of the Pygopodes. The basibranchial, seen from above, is more or less shield-shaped, and is produced anteriorly into a short blunt process, bent almost at right angles to the main axis, and posteriorly into a similar process, but in the same plane as the body of the bone. The anterior process supports a cartilaginous basihyal, the posterior supports the urohyal. The urohyal is entirely cartilaginous and rod-shaped. The ceratobranchials are separated one from another at the base by the median posterior process; each is about 3 times as long as the basibranchial; the epibranchial is about $\frac{1}{3}$ the length of the ceratobranchial, from which it is separated by a cartilaginous rod rather less than $\frac{1}{2}$ length of the epibranchial itself.

The Cranial Cavity.—The metencephalic fossa is well defined. Its floor is flattened, and continued backwards, rising gently meanwhile to the free edge of the occipital condyle. It rises gently at the sides. The vagus foramen pierces its posterior lateral margin, and to the inner side of this lie two small condyloid foramina for the xii. nerve. The internal auditory meatus lies immediately above the vagus foramen, in the body of the proötic. Anteriorly, the fossa rises somewhat abruptly and overhangs the pituitary fossa, forming the dorsum sellæ.

The cerebellar fossa is bounded by the supra-occipital and parietal behind and above, the pro- and epiotic laterally, and the dorsal rim of the foramen magnum behind. A low tentorial ridge cuts it off in front: ventrally it merges with the metencephalic fossa. The floccular fossa lying between the epi- and proötic is large and deep.

The mesencephalic fossa lies in the alisphenoid. The ventral portion of the tentorial ridge bounds it externally, the proötic and lateral region of the dorsum sellæ may be said to define it posteriorly. Its outer wall is pierced by the trigeminal foramen.

The pituitary fossa is very deep; its floor is pierced by two foramina leading outwards above the Eustachian grooves, at the point where the inner free border of the basisphenoid and parasphenoid plates meet one another to form the Eustachian tube. The dorsum sellæ is a flattened plate of bone sloping obliquely forwards over the pituitary fossa, and terminating at the oculomotor foramen. The pre-pituitary ridge slopes gently forwards; anteriorly to this, in the middle line, is a small triangular optic platform. The pre-optic ridge terminates on either side somewhat above the level of the tentorial ridge. The anterior border of the optic foramen is completed by the presphenoid, the posterior border by the alisphenoid.

The cerebral lies in front of the cerebellar fossa, the cerebellum not being covered by the cerebrum. The tentorial rises slightly below the level of the pre-optic ridge, sweeps backwards to the level of the junction of the epi- and proötics, then almost vertically upwards to the middle line, to terminate in the roof of the skull above the region of the dorsum sellæ. From this point forwards it is continued as a sharply defined ridge losing itself in the extreme anterior region of the fossa.

iii. The Skull of the Nestling.

The sutures of the skull, like those of Struthious birds, remain open for a very considerable time, being quite distinct in advanced nestlings. The Museum collection possesses two such skulls—one of *Catarrhactes chrysocome* about quarter-grown, and one of a half-grown *Pygoscelis papua* (Pl. LXI. figs. 1–3); and from these the following descriptions are taken.

The *occipital condyle* is almost entirely formed by the basioccipital, only a small portion being contributed by the exoccipital; a deep pit in its centre in the dried skull represents the remains of the notochord.

The *supra-occipital*, seen from without, is a vertically elongated bone of a rounded oval in outline and tumid in shape. It constitutes the characteristic "cerebellar prominence." It is bounded above by the parietal, and laterally by the epiotic, from which, in very young skulls, it is separated in part, superiorly, by a wide chink, and in part, inferiorly, by a deep groove. Its inferior border forms the upper boundary of the foramen magnum. There are traces, in the earlier stages, of an originally paired condition, in the shape of a mesial cleft running from the superior border downwards for about $\frac{1}{3}$ of its length; it then bifurcates, the two limbs terminating almost immediately after: later, as seen in a young *Pygoscelis*, the median cleft closes up, leaving a horseshoe-shaped fenestra representing the bifurcation, which, in its turn, disappears leaving in the adult no trace. The deep inferior groove separating the supra-occipital from the epiotic has in some cases been so imperfectly ossified as to release the supra-occipital entirely from the epiotic.

The *exoccipital* forms the infero-lateral border of the foramen magnum; from the point where it joins the supra-occipital it runs upwards and outwards under the epiotic: its supero-lateral external border is bounded in part by a large tract of cartilage forming the outer wall of the floccular fossa, and in part, below this tract, by the proötic. The ventrilateral border is ensheathed in cartilage and produced downwards to form the paroccipital process. Seen from within, it is found to be fused with the opisthotic, the boundary-line between the two bones being indicated only by a faint notch lying just in front of the condyloid foramen.

The lambdoidal suture does not quite correspond with the ridge of that name. This arises from the middle of the posterior border of the squamosal, and running upwards for a short distance along the posterior border of the parietal parts company with the margin, where it curves downwards over the epiotic and continues its curve transversely; ultimately to meet in the middle line a little short of halfway between the coronal and lambdoidal sutures.

The *parietals* have the form of oblong plates of bone running transversely across the skull (Pl. LXI. fig. 3). The frontal border is rounded off dorsally at the point where the two parietals meet in the middle line; the same region of the frontals is similarly deficient, hence a small diamond-shaped fronto-parietal fontanelle is formed. The alisphenoid border is very narrow in *Aptenodytes*, being encroached upon by the squamosal; in *Spheniscus* and *Catarrhactes* it is broad, rather more than $\frac{2}{3}$ the total width and incurved. In *Pygoscelis* it is of medium breadth—about $\frac{1}{2}$ the total width, and only slightly curved. The squamosal border in *Aptenodytes* is more than four times the extent of that of the alisphenoid border; in *Spheniscus* and *Catarrhactes* the squamosal and alisphenoid borders are of about equal length; in *Pygoscelis* the squamosal border is about twice that of the alisphenoid and perfectly straight. The supra-occipital border develops a strong out-standing ridge which runs downwards to the squamosal. This ridge leaves the free border of the parietal almost immediately after it passes over from the squamosal, and runs upwards, in the case of *Spheniscus*, to the level of the dorsal limit of the supra-occipital, but does not meet in the middle line. The development of this crest, at this stage, closely resembles the permanent condition of that of *Aptenodytes* and *Pygoscelis*, and, in a slightly lesser degree, that of *Catarrhactes* and *Eudyptula*, since in the adults of these latter the crest is more developed laterally. In the adult *Spheniscus* this parietal crest forms the large out-standing plate of bone—the squamoso-parietal wing—which runs upwards to join the narrow median sagittal crest. In this way the posterior portion of the deep "temporal fossa" is formed.

The *frontals* undergo marked change of form before reaching the adult condition. They form paired plates of considerable size extending forwards, under the nasals, as a pair of divaricating processes as far as the level of the anterior border of the lachrymal; and backwards, to a point corresponding with the level of a line drawn through the articulation of the quadrate with the squamosal. They leave a small fontanelle in the middle line at their junction with the parietal. The outer free border of each is sharply depressed and slightly hollowed when seen from without; this groove runs forwards to skirt the outer border of the nasals. The form which this groove ultimately acquires is of considerable importance for taxonomic purposes. (The nature and extent of these changes can be seen at a glance by comparing Pl. LXI. fig. 2 with Pl. LIX. fig. 2.) Thus, in the nestling the supra-orbital groove is represented by a shallow depression or hollowing out of the whole outer border of the frontal—the inner wall of the groove of the adult. The outer wall of the adult gradually arises from the inferior border of this inner wall, and eventually assumes the form of a huge overhanging ledge of bone with a wide, flattened, dorsal rim along its free edge. The condition of the groove in the adult skull of *Aptenodytes* affords a more or less intermediate stage between these two. It is interesting to note that Watson, in his memoir published in the 'Challenger' Reports (vol. vii. p. 6), described and figured the skull on which this description is based, and remarked that in ". . . . . *Aptenodytes* and *Pygoscelis* this ledge of bone does not exist . . . ."

The *basioccipital*, seen ventrally, is bounded on its outer sides by the exoccipital, and in front by the basitemporal. Posteriorly it is rounded off to form the main body of the occipital condyle. Seen dorsally, it is bounded in front by the basisphenoid, laterally by the proötic, opisthotic, and exoccipital. At this stage, in a very young nestling of *Catarrhactes chrysocome*, all these boundaries are clearly defined in cartilage, save that between the opisthotic and proötic. Soon after this all traces of these limits become obliterated.

The *exoccipital* is for some considerable time separated from the squamosal by a wide gap filled in by cartilage, through which the proötic has thrust itself (Plate LXI. fig. 3). Its supero-internal dorsal border abuts against the epiotic and supra-occipital bones, both of which can be readily distinguished. Below, and externally, it develops a short paroccipital process, which, however, never acquires a large size; separated from this by a wide groove is developed the mammillary process, abutting against the basioccipital at its junction with the basitemporal. Seen from within, the exoccipital appears as a small triangular area of bone wedged in between the opisthotic and the basioccipital and contributing to form the foramen magnum.

The *basisphenoid* is not visible externally, being concealed by the underlying basitemporal plate and its parasphenoidal rostrum. Internally, it is bounded, laterally, by the proötic and alisphenoid, posteriorly by the basioccipital, and anteriorly by the presphenoidal cartilage. Its dorsal border is hollowed out to form the ventral segment of the optic foramen. In front of the pituitary fossa it is continued forwards for a short distance in the form of a vertically compressed lamina resting on the parasphenoid.

The *orbito-* and *presphenoid* are as yet represented only by cartilage and are not to be separately defined.

The *alisphenoid* is more or less quadrate in shape. Its antero-dorsal border runs along the orbital plate and postorbital region of the frontal; its postero-dorsal border is arched and wedged in between the parietal and squamosal (Pl. LXI. fig. 3); its inferior border is deeply hollowed to form the upper segment of the trigeminal foramen; its antero-internal border joins the still membranous orbito-sphenoid, its lower angle contributing to form the optic foramen.

The *parasphenoid* externally is perfectly distinguishable. It may conveniently be divided into three regions:—(1) An elongated, median rostrum; (2) a pair of alisphenoidal wings; and (3) a pair of basitemporal wings, which last form the basitemporal plate (Pl. LXI. fig. 3). In the ventral view of the skull of a young *Pygoscelis papua* from which this description of the parasphenoid is taken, the anterior basicranial fontanelle and vestiges of basi-pterygoid processes are plainly seen. The rostrum is continued backwards to abut against the basisphenoid, expanding meanwhile into a pair of wings to form the basitemporal plate. This plate is narrow from before backwards, but extends laterally to the level of the outer border of the mammillary processes. Its anterior edge is free and forms the floor of the Eustachian grooves, which, later, become converted into tubes (p. 962). Seen laterally, this groove has the appearance of having been carved out of the base of the skull so as to present a steep face, looking forwards and at right angles to the main axis of the skull. The alisphenoid wings are separated from the basitemporal plate by a deep gorge, which later becomes converted into a tube for the internal carotid artery (Pl. LXI. fig. 3). They overlap the suture between the ali-sphenoid and proötic bones, and extend outwards as far as the trigeminal foramen. Immediately above the carotid canal lies a pneumatic foramen, which apparently terminates in the body of the basisphenoid. In sagittal section the basisphenoid cannot be distinguished from the basitemporal plate underlying it.

The *mesethmoid* remains distinct for some time, in the form of a vertical, linguiform plate of bone. Its posterior border is rounded and imbedded in a large interorbital plate of cartilage. Its anterior border is columnar. Its dorsal border expands laterally under the frontals and nasals, and, eventually, turns downwards as an ectoethmoidal ossification to rejoin the mesethmoid—forming a large olfactory cavity opening forwards and downwards into the posterior region of the olfactory chamber.

The *squamosal* varies somewhat in form. In *Aptenodytes*, *Catarrhactes*, and *Spheniscus* it takes the form of a vertically elongated bone. In the first-named its dorsal moiety is produced into anterior and posterior limbs, giving the whole a **Y**-shaped appearance; of these two limbs the anterior is the more pronounced.

In the two latter genera the anterior limb is wanting. In *Pygoscelis* (Pl. LXI. fig. 3) the vertical height is relatively less; the anterior limb is wanting, as in *Catarrhactes* and *Spheniscus*; the posterior is of considerable length. The anterior and dorsal borders, in *Pygoscelis*, form a right angle; the posterior is deeply hollowed, as seen in the figure. Between the free end of the posterior limb and the epiotic is a wide space; into the lower portion of this the proötic has thrust itself. The upper portion of this space was originally filled in by cartilage and formed the outer wall of the floccular fossa, as seen in the skull of a young *Catarrhactes*; it is now filled up by an inward growth of the posterior border of the parietal. Below the curved upper limb lies the proötic, which runs backwards to join the exoccipital. The extreme anterior end of the proötic is seen peeping out in front of the supero-anterior squamosal border behind the alisphenoid. The squamosal, at this stage, articulates with the parietal only and rests upon the outer surface of the proötic. It is entirely shut off from the cranial cavity.

The *epiotic* (Pl. LXI. fig. 3) is sharply divided from the supra-occipital by a wide cleft running downwards and inwards from the lambdoidal suture, which terminates at about the middle region of the epiotic in a groove—afterwards converted into a closed canal—for one of the cerebral veins. This groove divides the lower end of the epiotic, as does the cleft the upper end, from the supra-occipital. Seen from without it is bounded mesially by the supra-occipital, superiorly by the parietal, and laterally by the proötic and exoccipital. Its supero-lateral border is bounded by cartilage (a synchondrosis); its postero-lateral border by a close suture. Seen from within, the epiotic is found to be fused by its postero-internal border with the supra-occipital, from which it is separated above by the wide chink already described (p. 967). Its lateral and external border is separated synchondrosially from the proötic and lateral occipital. In conjunction with the proötic forms the floccular fossa.

The *proötic* is largely visible from without, till comparatively late in life (Pl. LXI. figs. 1 & 3). In the youngest skull from which these descriptions are taken (*Catarrhactes chrysocome*), it can be seen in the hinder region of the skull through a mass of cartilage forming a small island, between the exoccipital, squamosal, parietal, and epiotic. In the lateral view of the skull, after removal of the quadrate, it can be seen lying between the exoccipital behind and the alisphenoid in front: below it rests on the pretemporal wing of the basisphenoid; above it is covered by the squamosal. After the removal of this, the boundaries of its upper end can be clearly made out. It is found to be wedged in between the alisphenoid and parietal above and in front, the exoccipital behind, and the epiotic mass of the supra-occipital within. Its anterior border is deeply hollowed to form the posterior border of the trigeminal foramen. Behind and above lies a glenoid cavity for the quadrate. Its posterior border is also hollowed out to form the anterior segment of the circular aperture of the fenestra ovalis.

The internal and external nasal processes are of great length; the former is the longer, and turns inwards at about its middle in the form of a long rod to underlie the nasal process of the premaxilla. The free border of the posterior, laminate portion of the nasal may meet in the middle line in the form of a rounded curve, or it may be interrupted in this region by the invasion of the interorbital ridge of the frontal, as in *Pygoscelis*.

The nasal processes of the premaxilla are cleft to within about one-fifth of the extreme tip of the jaw; the posterior, free ends of these processes rest upon the mesethmoid; on either side they are embraced by the nasals. The maxillary process runs above the maxilla, terminating near the middle of the inferior boundary of the lachrymo-nasal fossa.

The *maxilla* is produced forwards into a long slender splint, below the inferior border of the maxillary process of the premaxilla to within a short distance of its tip, thus forming almost the entire inferior border of the upper jaw, and backwards as a somewhat splint-like rod to assist in forming the quadrato-jugal bar. Above, it is bounded anteriorly by the maxillary process of the premaxilla and posteriorly above by the jugal, and below by the quadrato-jugal. Its backward extension terminates on a level with a line passing at right angles through the articulation of the pterygoid and quadrate. On the inner side, near its anterior $\frac{1}{3}$, on a level with the articulation of the external process of the nasal with the premaxilla, it gives off a curved rod-like maxillo-palatine process. The body of this is excavated to form the antrum of Highmore. These processes curve inwards on either side so as to embrace the vomer between them, though it does not actually touch them. They do not extend back beyond the level of a vertical line passing through the middle region of the lachrymals.

The *jugal* is a long slender splint, resting for the most part upon the posterior limb of the maxilla. It extends forwards, to the junction of the external process of the nasal with the maxillary process of the premaxilla, and backwards, along the outer side of the quadrato-jugal to within about one-fifth of its posterior articular end. The quadrato-jugal is of considerable size, extending forwards to the level of the posterior angle of the inferior pedate extremity of the lachrymal. The precise relations of the bones composing the quadrato-jugal bar can be well seen in Pl. LXI. fig. 3.

The *lachrymal* is permanently free, columnar in form, with a laminate or flange-like anterior border, and with expanded obliquely placed extremities. Its superior or dorsal end is applied to the under surface of the nasal, and its inner border to the anterior extremity of the frontal underlying the nasals. Generally the flange-shaped anterior border is perforated by a foramen, but this is not a constant character, the foramen being sometimes converted into a notch. In *Pygoscelis*, *Spheniscus*, and *Aptenodytes* little, or nothing, of the lachrymal is visible when the skull is viewed dorsally, either in the young or adult. In *Catarrhactes* it appears as a narrow ledge outside the nasal. This fact, with some others, serves at once to distinguish the skull of any of the *Spheniscidæ* from that of any of the *Colymbidæ*, in which this bone forms a very prominent, outstanding process.

The *vomer*, which is permanently free, is double, but the two halves are united along the anterior half of the inferior border; the posterior half of the dorsal border of each articulates with the palatine of its own side.

The *palatines* underlie the maxillæ, and with them extend forward to within a short distance of the tip of the upper jaw. Posteriorly, in the region corresponding with the level of the lachrymal, the flattened, splint-like form becomes greatly expanded, and turns slightly inwards and dorsally. The anterior border assumes a more or less scroll-like form and sends forwards along each half of the vomer a short rod, which apparently never projects beyond the level of the anterior border of the mesethmoid. The outline of the posterior border varies slightly in the different genera and species.

The *pterygoid* is rod-shaped, greatly expanded and flattened distally. Like the palatine, it differs slightly in shape, and is accordingly of some help in identifying species and genera. In young birds, and in young birds only, it is continued from the articular end of the palatine, forwards over its dorsal border, in the form of an elongated triangular rod of bone, terminating in an acute point over the extreme posterior extremity of the vomer (Pl. LXI. fig. 3). Almost immediately behind the posterior end of the palatine, this anterior portion of the pterygoid becomes segmented off from the main body of the bone, and later, a perfect arthrodial joint is formed. Meanwhile, the triangular anterior end has fused with the palatine, making it appear that the joint at the distal end of the pterygoid is a true palato-pterygoid articulation. There is nothing to show that the joint is secondary, and that it is formed by the unequal segmentation of the pterygoid itself.

In some other forms this pterygoidal segmentation takes place at the level of the posterior border of the palatine, instead of a little caudad of this.

This anterior segment has been frequently described and figured, in many different groups, by the late W. K. Parker, as a mesopterygoid. A short time ago I gave a brief description (**13**) of what seemed to me to be the real significance of this stylet, not knowing then that this had been more or less clearly grasped by Menzbier (**11**). His description is, however, somewhat meagre, and neither here nor in his figure does he hint at the segmentation of the pterygoid which eventually takes place, though he must have been perfectly well aware that such a process occurred.

As Menzbier has pointed out, the relations of these parts which exist temporarily in the Penguin obtain permanently amongst the Ratitæ. *Dromæus* and *Rhea* furnish two admirable examples. In the former, the pterygoid takes the form of an obliquely placed, flattened lamina tapering to a point forwards. The ventral border of its anterior half rests upon the flange-like projection from the dorsal border of the posterior limb of the paired vomer: the two becoming, in the adult, entirely fused so as to leave no trace of the line of their union.

In *Rhea* it is of exactly the same shape anteriorly as the small splint in Spheniscidæ, and runs forward along the dorsal border of the posterior end of the vomer, just as, only to a greater extent, it does in the young Carinate skull. In the case of *Rhea*, however, the inferior surface of this end of the pterygoid is grooved, and into this groove the postero-internal angle of the palatine and the outer superior border of the posterior limb of the vomer are received.

That this "hemipterygoid" [1], as I propose to call this anterior segment of the pterygoid, in the Carinatæ, is a part of the true pterygoid, and that it represents an earlier phase when the relations between the pterygoid and vomer were precisely similar to what obtains amongst the Ratitæ and Tinamous at the present day, is highly probable. Originally then, in the "Carinatæ," as in the "Ratitæ" now, the pterygoid terminated in a point resting on the vomer and was unsegmented; since, it has divided into an anterior and a posterior moiety, a joint forming between the segments. The pterygoid of the adult represents only the posterior and larger portion, the anterior having fused with the palatine. This state of things may probably be interpreted as the result of mechanical stress causing a fracture at the weakest part of the bone, such stress being brought about by the shifting of the palatines towards the middle line from their originally dromæognathous position.

From the relations between pterygoid and vomer, we may turn profitably to the relations between pterygoid and palatine.

In the Ratitæ, as represented by *Dromæus* and *Rhea*, the palatines are more or less triangular in form and do not extend forwards beyond the level of the posterior border of the maxillo-palatine processes. In the Carinatæ they extend forwards by means of a rod-like splint nearly to the tip of the upper jaw.

In *Dromæus* the palatine is attached to the outer border of the dorsal surface of the posterior limb of the vomer on each side, and is not in any way connected with the pterygoid. Thus, on a ventral view of the skull, the vomer is continued directly backwards to the pterygoids, its two posterior limbs forming with each of the latter a continuous bar. In *Rhea* the anterior half of the internal, or mesial, border of the palatine articulates with the posterior limb of the vomer of that side, the posterior half with the pterygoid. Thus the vomer appears to be entirely separated from the pterygoid by the palatine. Moreover the latter is being

[1] For this word I have to thank Prof. G. B. Howes, F.R.S., of the Royal College of Science, whose aid I sought after having failed to coin a name to my own satisfaction.

slowly brought into relation with the parasphenoidal rostrum. If the palatine be carefully removed, however, the spine-like anterior end of the pterygoid will be found to run along the superior border of the posterior limb of the vomer, though for a short distance only. The condition of things which obtains here between the pterygoid and vomer permanently is represented, more or less perfectly, for a short time in the life-history of many, if not all, Carinatæ.

But to return to the palatines. In Carinatæ more or less of the anterior region of the internal border of each palatine articulates with the vomer—which, though still paired, is generally more or less blade-shaped, and not, as in the Ratitæ, depressed and laterally expanded; the remainder, meeting its fellow of the opposite side below the parasphenoidal rostrum, runs back to articulate with the pterygoid. Thus, in a ventral view of the skull, the vomer lies wedged in between the palatines and appears to be far removed from the pterygoids, having apparently been thrust forwards by the approximation of the palatine toward the middle line. Seen dorsally, however, in the young skull, the internal palatine border is found to be still in part connected with the vomer and in part with the pterygoid, as in *Rhea*—the connection being made by means of the hemipterygoid. If this connection is now in a vanishing quantity, it still undeniably exists.

The Mandible.—All the elements which take part in the formation of the lower jaw are present (Pl. LXI. figs. 1 & 3). The relations between the coronoid and splenial most nearly resemble those of the Crocodilia amongst the Reptiles, the coronoid lying behind the splenial. In its elongated form and superior size, however, the coronoid differs from all the Reptilia, and resembles the rest of the Aves. Within the Class, the form and relations of these two bones one to another and to the neighbouring parts vary slightly, and may prove to be characters of some value in systematic work. In a young *Catarrhactes chrysocome*, as shown in Pl. LXI. fig. 1, the coronoid extends from behind forwards as far as the middle of the ramus. Its posterior end is expanded and closely applied to the articular, from which, however, it can be clearly distinguished. The splenial is a large lozenge-shaped lamina lying in front of, and below, the anterior end of the coronoid. The greater part of its superior border is overlapped by the dentary. The articular is wedged in between the posterior ends of the coronoid, on the inside, and the supra-angular and angular, on the outside. The supra-angular runs forwards to join the dentary at about the middle of the ramus. It is perforated, rather behind its middle, by the posterior lateral vacuity. The angular underlies the supra-angular, and forms the inferior border of the jaw from the dentary backwards; it appears on the inside, where it overlaps the coronoid for some considerable distance. Its extreme anterior end is concealed on the inside by the splenial, on the outside by the dentary. The form of the dentary supra-angular suture has been described in the adult (see p. 965).

iv. The Vertebral Column.

The vertebral column is singularly uniform in character throughout the group. The cervicals are peculiar chiefly on account of the great development of the metapophyses and hyperapophyses of certain vertebræ.

The thoracic vertebræ are opisthocœlous and somewhat closely resemble those of *Phalacrocorax*, from which they may be distinguished by the great development of the styloid processes, seated on the anterior border of the transverse process midway between the capitular articulation for the rib and the centrum. The synsacral hypapophyses found in *Phalacrocorax* are absent in the Penguins.

The synsacrum is a dense bony mass which remains unanchylosed with the innominate bones throughout life. On a ventral view, the lumbar swelling is seen to be very large. The outer ends of the last thoracic and the first two lumbar vertebræ fuse together to enclose a pair of holes on each side: behind, in the middle of the lumbar enlargement, are seated a pair of short, thick parapophyseal elements abutting against the ilium. The renal fossa cannot be definitely separated into anterior and posterior portions. The true sacral vertebræ are not, in very old specimens, easy to make out: they are enclosed in the hexagonal mass lying opposite the acetabulum and ilio-ischiadic foramen. Three vertebræ take part in the formation of this mass, of which the 2nd and 3rd represent the two primitive sacrals. From 1 to 3 of the caudals may be included in the synsacrum, according to age. None of the synsacral vertebræ bear hypapophyses. Dorsally, the region of the synsacrum, between the hexagonal sacral mass and the first pair of parapophyseal elements anterior to this, is much expanded. In the complete pelvis this lies immediately cephalad of the acetabulum. In the region behind this it is more or less constricted. The synsacrum is composed of from 12–14 vertebræ. The pygostyle (Pl. LXI. fig. 5) is composed of about 6 vertebræ, the neural spines of which run directly forwards and parallel with the vertebræ and overlap the spine next in front. The vertebræ cannot be generically distinguished.

There are from 9–10 pairs of free ribs. The first two pairs are those of the cervico-thoracic vertebræ. Of these, the first takes the form of an elongated bony style; the second represents a complete dorsal rib, but has no sternal segment, and bears an uncinate process. The remaining ribs increase in length and slenderness from before backwards, and all but the last bear uncinates. These, in the 1st to 4th ribs, are very long and broad. There is frequently, perhaps always, an extra pair of sternal ribs closely attached to the posterior border of the sternal segment of the last thoracic rib.

v. The Pectoral Girdle and Sternum.

The pectoral girdle of the adult Penguin is of the same general form throughout the group.

The *coracoid* is a stout bone, typically about half as long as the sternum. The precoracoid is large in all. In an example of *Pygoscelis papua* it extends almost the whole length of the coracoid. The supracoracoid foramen is complete in all but *Aptenodytes* and *Pygoscelis*. The acrocoracoid is fairly well developed; in *Pygoscelis* and *Spheniscus magellanicus* it forms a conspicuous, downward and inwardly projecting spur.

The form of the scapula is unique, being of great length and shaped like a scimitar; the convex border is dorsal, the concave ventral. In *Aptenodytes* and *Pygoscelis* it is sharply truncated posteriorly; in *Spheniscus* and *Eudyptula* the inferior angle of this posterior border is rounded off, so that the free end of the bone assumes a somewhat pointed form. That of *Catarrhactes* can be more or less distinguished from that of *Spheniscus* by the greater curvature of its superior border, and the acute angle formed at the hinder end of the inferior border, giving the scapula a truncated appearance posteriorly, similar to that of *Aptenodytes*. In *C. chrysolophus*, however, this is less marked, and makes it somewhat difficult to distinguish from the scapula of *Spheniscus*. There is a well-marked acromial process for the articulation of the free end of the clavicle.

The *furcula* is U-shaped and much curved, its convexity looking forwards and downwards. There is no hypocleideum. Its free end forms a slight roughened expansion for articulation with the acromial process of the scapula. Ventrad of this is a more or less oval irregular surface for articulation with the acrocoracoid. From the level of this articulation downwards, the limbs of the furcula are laterally compressed, but they gradually take on a rounded form as they approach the symphysis.

The *sternum* is about half as broad as long, with a pair of notches posteriorly. The keel in all cases projects beyond the corpus sterni. In *Aptenodytes* this is a very marked feature indeed, the anterior border sloping obliquely forwards and downwards for about one-sixth of the total length of the sternum. In all but *Aptenodytes* there is a well-marked *spina externa*. This is more or less marked by the forward continuation of the keel. In some it is well marked. In *Aptenodytes* the anterior border of the keel passes directly into the *corpus sterni*. The form of the *spina externa* and of the anterior border of the keel is very variable, even among species of the same genus, so that no value can be placed on it as a systematic factor. There is no *spina interna*.

The anterior lateral processes project forwards and outwards, the base of each on either side runs from the inner end of the coracoid groove outwards to the external border of the *corpus sterni*. Along this border, at the point where the two regions may be said to meet, is placed the articular surface of the sternal segment of the 1st thoracic rib. There are altogether 6 of these articular surfaces.

The coracoid grooves are widely separated in the median line; the "dorsal lip" is represented by a slight projection near the inner end, and the "ventral lip" by a somewhat more developed process near the outer end, of the groove. The groove is slightly curved, its convex surface being ventral, fairly wide, and deep.

The posterior lateral processes are of great length in *Aptenodytes* and *Pygoscelis*, longest in the latter, where they may exceed the coracoid in length. They are slightly curved (outwardly), and tend to meet in the middle line behind the metasternum throughout the group. Only in *Catarrhactes chrysolophus* and *Eudyptula minor* are they so curved as to make the width across from the process of one side to that of the other so great as to be equal to (*Eudyptula*) or greater than (*Catarrhactes*) that across the anterior lateral processes. The width of the posterior lateral processes themselves varies slightly. From near the middle of each process there arises a strong ridge, which runs forwards to terminate in the lateral border of the *corpus sterni*; which, it should be remarked, is bent, or reflected downwards to form a wide overhanging ledge on each side of the sternum. The metasternum is variable in shape, being either pointed or rounded in form.

The sternum remains as a single cartilaginous plate with a low median keel till long after the coracoids and scapula have ossified. In a half-grown *A. forsteri* in the Collection, the sternum is represented by a pair of rhomboidal plates fused in the middle line from before backwards to the posterior third, where they remain widely separated. The keel is very feebly developed, and, as in Steganopodes, is produced far forwards beyond the level of the sternum, and tapers rapidly backwards to disappear in the neighbourhood of the sternal cleft just referred to.

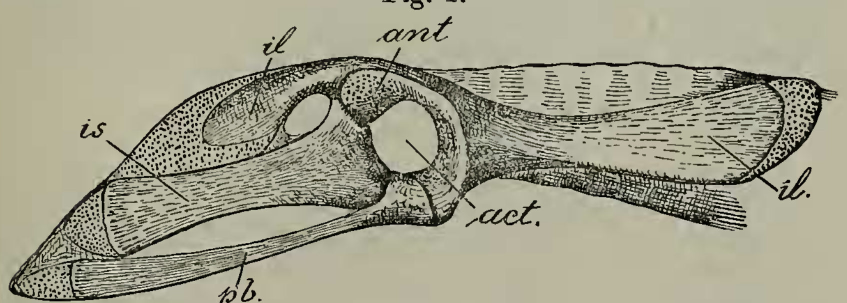
vi. The Pelvic Girdle. (Fig. 1, p. 979.)

The pelvis of the Impennes is not readily comparable with that of any other group. Its most distinctive character is the great backward rotation of the innominate bone. This is readily seen if the pelvis is held so as to bring the synsacrum to the vertical. A line drawn through the pre-ilium and pubis would describe an angle of about 25°. Both external and internal borders of the pre-ilium are greatly hollowed immediately in front of the acetabulum. The ilio-ischiadic foramen never greatly exceeds the acetabulum in size. The obturator foramen is never complete. The pubis (*pb.*) never greatly exceeds the ischium (*is.*) in length, is nearly or quite straight, and runs parallel with the ischium, leaving a long obturator fissure. Its free end never turns inwards. The ischium is fused with the post-ilium, beyond which it projects slightly, and, like the post-ilium, tapering to a point posteriorly forms a notched posterior border. The post-ilium is expanded immediately over the ilio-ischiadic foramen; behind this it forms a sharp ridge projecting considerably on either side above the level of the synsacrum.

Except in *Pygoscelis papua*, the innominate bones remain widely separated by, and free from, the synsacrum throughout life. The pre-ilium in no case quite reaches the fused neural spines of the synsacrum; in *Aptenodytes* the pre-ilia are more markedly separate than in any other genus.

In a nestling *Aptenodytes* the acetabulum is bounded, anteriorly by the pre-ilium, posteriorly by the ischium and pubis. The ischium bears a share in the formation of the antitrochanter. The pubis is nearly as broad as the ischium and only slightly longer; the post-ilium falls far short of the hinder end of the ischium, from which it can be easily distinguished by a faint line running forwards to the ilio-ischiadic foramen. It is noteworthy that it is not divided by a fissure from the ischium as in the young of many other birds, or as in the case of the Struthious birds and Tinamous. This is probably a secondary feature due to the extreme backward rotation of the ischium and pubis. The anterior and posterior renal fossæ are not sharply defined. The synsacral foramina in the acetabular region are minute. The form of the pelvis is very uniform throughout the group: such points as are of systematic value will be found in the appended "Keys."

Fig. 1.



Lateral view of the innominate of a nestling *Catarrhactes chrysocome*, to show the separate elements.

ant., anti-trochanter; *act.*, acetabulum; *il.*, ilium; *is.*, ischium; *pb.*, pubis.

vii. The Pectoral Limb.

The bones of the wing in the Impennes can only very imperfectly be distinguished either specifically or generically one from another. The wing of *Aptenodytes* can be distinguished from that of any other genus by its superior size, the humerus being not less than 4·4 inches in length. That of *Pygoscelis papua* comes next, being 3·5 in. Except in the slightly superior size of the pneumatic fossa, the wing of the smaller species of *Pygoscelis* cannot be distinguished from that of *Catarrhactes* or *Spheniscus*. The last two genera are almost indistinguishable one from another. That of *Spheniscus* may perhaps be distinguished from that of *Catarrhactes* by the size of the ulnare. This, in all, is triangular in shape, but in *Spheniscus* only, apparently, is the width of the base—the postaxial border—but slightly greater than the height;

in other genera the base of the triangle greatly exceeds the height from base to apex. *Eudyptula* is easily distinguishable from the remaining genera on account of its small size; the ulna does not exceed 2 in. in length—the whole wing is under 5 in.

The most striking feature of the wing is the remarkable compression or flattening, dorso-ventrally, which the bones have undergone. The sub-trochanteric (pneumatic) fossa of the humerus is of great size, as in many Anatidæ; in the Penguins, however, the fossa is non-pneumatic. The pectoral crest does not project beyond the level of the shaft; the pectoralis major is inserted into a deep oblong fossa on its ventral aspect. The coraco-humeral groove is well-marked. The head of the humerus is reniform, the hilus being ventral. The distal articular end is obliquely truncate; the radial and ulnar condyles lie one behind the other, and from behind the latter the shaft is produced into a sharp angle, the free border of which is grooved; there is a second groove dorsad of this perfected by a large projecting upper lip. In these two grooves run two sesamoids, the form and relations of which have been frequently described.

In a half-grown nestling of *C. chrysocome* the 1st metacarpal is quite separate from the 2nd and tipped with cartilage—representing the 1st phalanx. The terminal phalanges of the 2nd and 3rd metacarpals are likewise tipped with cartilage, and similarly may represent phalanges. The ulnare at this stage is entirely cartilaginous.

viii. The Pelvic Limb.

The most characteristic feature of the pelvic limb is the distinctness of the three metatarsals, usually merged together into a longer or shorter single cylindrical shaft. In the Penguins 3 metatarsals are always distinguishable, separated one from another by grooves more or less deep. On either side of the 3rd metatarsal, on anterior view, lie 2 foramina; just below the insertion for the tibialis anticus these pass through to appear just below the bases of the two more or less distinct calcaneal ridges. The form of the tarso-metatarsus in the Impennes is closely approached by that of *Fregata* (a Steganopodous bird); but it can easily be distinguished therefrom by the fact that in *Fregata* the 2nd trochlea is longer than the 3rd and is directed backwards, and by the presence of a foramen at the distal end between the 3rd and 4th trochleæ. In *Sphenisci* this foramen is wanting, and the 2nd trochlea is shorter than the 3rd and is not directed backwards. It has been suggested that this distinctness of the metatarsals in the Impennes is pseudo-primitive and probably induced by the plantigrade habit of walking. The Penguins are, however, *not* plantigrade; and it is a significant fact that both in this group and in *Fregata* the legs are comparatively little used for the support of the body. Thus it is possible that on this account the metapodial region may have retained a nearer approach to the primitive condition than in other forms. They represent a halfway stage between the primitive, completely separate metatarsals on the one hand, and the highly specialized "cannon bone" on the other, where the three metatarsals are all merged to form a single shaft.

The total length of the tarso-metatarsus is about one-fourth that of the tibio-tarsus. The hypotarsus is simple, consisting of an ecto- or an ecto- and entocalcaneal ridge, but they are never more than low prominences.

The tibio-tarsal shaft is perfectly straight, and about one-fifth longer than the fibula. Ecto- and entocnemial crests are well-developed in the adult, but there is no trace of them in the half-grown *C. catarrhactes* from which this description was taken.

The shaft of the femur is very thick, its length about twice that of the tarso-metatarsus. Like all the other bones of the leg, it is non-pneumatic.

ix. Summary.

Mr. Grant (**10**) and I both find it necessary to divide the Order Impennes into 6 genera (*cf.* p. 982). Of these, *Eudyptula* appears to represent the least specialized form of the whole group, and probably lies nearest the ancestral stock. The diagram (fig. 2) is intended to express, as nearly as may be, the possible relationship of the various genera one to another. As has been already pointed out by Gadow (**7**) and Beddard (**1**), the group as a whole seems to be most nearly related to the Tubinares.

Fig. 2.

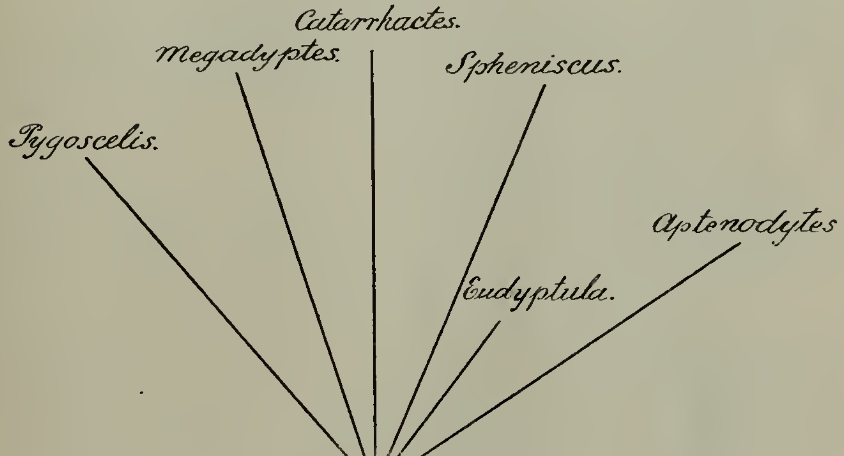


Diagram showing the probable relationships of the various genera of the Family Spheniscidæ.

I am unable to distinguish the skeleton of *Catarrhactes pachyrhynchus* from that of *C. chrysocome*. *C. sclateri* and *C. schlegeli* are not yet represented in the collection of skeletons. Skeletons of *Spheniscus humboldti* and *S. mendiculus* are also wanting.

x. Key to the Osteology of the Impennes, *based on characters of the adult skeleton.*

A. Skull (Plates LIX.–LXI.)[1].

Beak never hooked; nares pervious, holorhinal; basipterygoid processes absent; palate schizognathous; vomer blade-shaped, paired, the two halves united along the antero-ventral border, never anchylosed with the palatines; palatines broad and flattened posteriorly; pterygoids expanded into flattened laminæ distally, never rod-shaped; interorbital septum perforate; with deep supra-orbital grooves; lachrymal free, never contributing to form the supra-orbital grooves, and without conspicuous squamoso-parietal wings when the skull is seen dorsally, its lower limb pedate, articulating with the quadrato-jugal bar; maxillo-palatine processes in the form of slender curved rods, never laminate.

Key to the Genera.

A. Posterior region of the temporal fossa not extending on to the cerebellar prominence; the squamoso-parietal wing bounding the fossa posteriorly, terminating on the cerebral dome at or below the level of a long transverse lambdoidal ridge; coronal ridge absent.

- *a.* Quadrato-jugal bar greatly curved.
  - *a'.* Supra-orbital ledge feebly developed, decreasing in size from behind forwards and becoming obsolete at the level of the frontal end of the nasal bones; supra-orbital grooves closed posteriorly by a strong bony wall; posterior ends of nasal processes of premaxilla separate one from another and from the nasals throughout life... *Aptenodytes.*
  - *b'.* Supra-orbital ledge greatly developed, with its free edge flattened dorsally.
    - *a''.* Width of coronal ridge much exceeding the width across nasals between lachrymals; squamoso-parietal wings feebly developed; posterior region of temporal fossa shallow.
      - *a^3.* Nasal processes of the premaxilla slender, free posteriorly one from another and more or less easily distinguishable throughout from the superior limb of the nasals; inferior border of the squamosal prominence longer than that of the paroccipital process; width of supra-orbital groove exceeding the height of the vertical axis of the foramen magnum; lower jaw with the inferior limb of the posterior (caudad) end of the dentary with a straight superior border .... *Pygoscelis.*
      - *b^3.* Nasal processes of the premaxilla conspicuously thickened, fused posteriorly more or less completely one with another and with the superior limb of the nasal; inferior border of the squamosal prominence less than that of the paroccipital process; width of supra-orbital groove less than the vertical axis of the foramen magnum; lower jaw with inferior limb of posterior end of dentary short and deep, and with a strongly pronounced sinuous free border .... *Catarrhactes.*
    - *b''.* Width of coronal ridge not exceeding width across nasals between the lachrymals; squamoso-parietal wings well developed; posterior region of temporal fossa wide and deep; nasal processes of premaxilla slender, free posteriorly one from another and from the superior limb of the nasals; inferior borders of squamosal prominence and paroccipital process equal; width of orbital groove less than height of vertical axis of foramen magnum; lower jaw having the inferior limb of the posterior end of dentary produced far backwards, and with a strongly arched superior border... *Megadyptes.*

[1] Of the Keys appended, that of the skull expresses the systematic arrangement adopted in this paper. The rest are designed not for systematic work, but for the purpose of facilitating the identification of the different parts of the skeleton when isolated.

b. Quadrato-jugal bar slightly curved.

c'. Supra-orbital ledge nearly obsolete, not extending far beyond the base of the postorbital process; supra-orbital groove shallow, bounded posteriorly by a bony ridge .... *Eudyptes.*

B. Posterior region of the temporal fossa very deep, extending mesially on to the cerebellar prominence, separated dorsally from its fellow of the opposite side by a median sagittal ridge; transverse lambdoidal ridge absorbed by the squamoso-parietal wings, which are largely developed; with a coronal ridge distad of the sagittal crest .... *Spheniscus.*

Key to the Species.

Aptenodytes.

a. Upper jaw slightly longer than the cranium (·4 in.); squamoso-parietal wings almost obsolete; coronoid of lower jaw long, extending far forwards above middle of splenial, terminating near the middle of the jaw. *A. forsteri.*

b. Upper jaw markedly longer than cranium, more than $\frac{1}{3}$; squamoso-parietal wings extending nearly the whole height of the temporal fossa; coronoid short, not extending beyond the posterior $\frac{1}{3}$ of the jaw ... *A. patagonicus.*

Pygoscelis.

a. Dorsal border of free edge of supra-orbital ledge of great breadth (Pl. LIX. fig. 2); posterior region of temporal fossa moderately deep: total length of skull 6 in. .... *P. papua.*

b. Dorsal border of free edge of supra-orbital ledge about ·1 to ·2 in width; skull less than 5 in. long; interorbital region of frontal immediately behind nasals reduced to a slender ridge dividing the supra-orbital grooves.

a'. Upper jaw not greatly depressed, markedly longer than cranium; pterygoids longer than vomer; length of anterior nares equals width across skull behind the postorbital processes .... *P. antarctica.*

b'. Upper jaw markedly depressed, equal to or less than cranium in length; pterygoids equal vomer in length; length of anterior narial aperture much less than width of skull behind postorbital processes. *P. adeliæ.*

Catarrhactes.

a. Inter-orbital region of frontals behind the nasals forming a broad ridge.

a'. Size smaller, not exceeding 4·3 in. .... { *C. chrysocome.* *C. pachyrhynchus.* }

b'. Size larger, not exceeding 4·6 in.......................... *C. chrysolophus.*

Eudyptula.

a. Skull 3·5 in.; transverse lambdoidal ridge equals length of narial aperture. *E. minor.*

b. Skull 3·8 in.; transverse lambdoidal ridge less than length of narial aperture. *E. albosignata.*

Spheniscus.

a. Squamoso-parietal wings greatly developed, superiorly separated from the coronal ridge by a long and often wide sagittal ridge; cerebellar dome not well developed; supra-orbital ledge sharply truncated anteriorly in the region of the posterior $\frac{1}{3}$ of the supra-orbital groove... *S. demersus.*

b. Squamoso-parietal wings well developed, superiorly running forwards so as nearly to join the coronal ridge; supra-orbital ledge obsolete. *S. magellanicus.*

B. Vertebræ.

All the presynsacral vertebræ are free; all the thoracic vertebræ are opisthocœlous; all the cervicals, save the atlas and axis, have a bony carotid canal, formed by an outgrowth from the lower surface of the anterior zygapophysis which extends downwards to the capitulum of the cervical rib; there are eight caudals, not including the pygostyle, which is made up of about six vertebræ.

Key to the Genera.

A. Neural spines on 2–6; 5–9 with elongated cervical ribs; 2–4 with moderately large hyperapophyses; 12–14 with large metapophyses; last cervical and first dorsal with 1 to 3 bifurcate hypapophyses. *Aptenodytes.*

B. Cervicals 4–11 with elongated ribs, on 4 and 5 in *P. tæniata* extending back to the end of the centrum; 2–5 with very long hyperapophyses; 12–14 with much elongated metapophyses; last cervical and first 4 thoracic vertebræ with bifurcate hypapophyses............... *Pygoscelis.*

C. Cervicals 4–9 with elongated ribs; 2–5 with elongated neural spines; 2–8 with much elongated hyperapophyses decreasing from before backwards; 11–12 with elongated metapophyses; first and second thoracic vertebræ only with bifurcate hypapophyses ...... *Catarrhactes.*

D. Cervical ribs of 5–8 vertebræ only conspicuous; in vertebræ anterior and posterior to these, the rib scarcely projects beyond the lateral and ventral laminæ forming the carotid canal; hyperapophyses on 3–6; metapophyses of posterior cervicals (12–13) not greatly elongated; hypapophyses of last cervical and 1–3 thoracic vertebræ bifurcate. { *Spheniscus.* / *Eudyptula.* }

The vertebral formula is:—

$$\text{Cv. } 13;\ \text{Cv. th. } 2;\ \underbrace{\text{Th. } 5+1}_{6};\ \text{Lb. } 4;\ \text{Lb. sc. } 4;\ \text{Sc. } 2;\ \text{Cd. } \underbrace{1+9}_{10} = 41.$$

C. Sternum and Pectoral Girdle.

Corpus sterni half as broad as long, with a pair of notches posteriorly, a spina externa, and with the keel projecting forwards beyond *corpus sterni*; precoracoid and acrocoracoid large; scapula of great breadth and truncated posteriorly.

Key to the Genera.

A. Length of coracoid equal to distance from anterior border of corpus sterni to the middle of the posterior lateral process; length of posterior lateral process less than that of coracoid; anterior border of keel projecting far forwards .... *Aptenodytes.*

B. Length of coracoid less than the distance from anterior border of sternum to middle of posterior lateral process.

  a. Posterior lateral process equal to or longer than the coracoid; supracoracoid foramen rarely complete .... *Pygoscelis.*

  b. Posterior lateral process less than coracoid; supracoracoid foramen complete.

    a′. Length of sternum more than 3 in.

      a″. Posterior end of scapula truncated .... [1] *Catarrhactes.*

      b″. Posterior end of scapula rounded .... *Spheniscus.*

    b′ Length of sternum not exceeding 3 in. .... *Eudyptula.*

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[1] The form of the scapula in *C. chrysolophus* closely approaches that of *Spheniscus*, from which genus the sternum and shoulder-girdle of this species can be easily distinguished by reason of the great width across the posterior lateral processes (see p. 978).

Key to the Species.

APTENODYTES.

a. Size larger; sternum 12 in.; sternum and coracoid 15·7 in. *A. forsteri.*

b. Size smaller; sternum 9·5 in.; sternum and coracoid 12 in. *A. patagonicus.*

CATARRHACTES.

a. Width across posterior lateral processes less than that across anterior lateral processes .... *C. chrysocome.* / *C. pachyrhynchus.*

b. Width across posterior lateral processes greater than across anterior lateral processes .... *C. chrysolophus.*

SPHENISCUS.

a. Size larger; sternum not exceeding 5·10 in. measured from between coracoid grooves to free end of posterior lateral processes; length of scapula less than corpus sterni .... *S. magellanicus.*

b. Size smaller; sternum not exceeding 5 in.; length of scapula equals that of corpus sterni .... *S. demersus.*

EUDYPTULA.

a. Width across anterior and posterior lateral processes equal. *E. minor.*

b. Width across anterior lateral processes greater than across posterior lateral processes.. *E. albosignata.*

D. PELVIC GIRDLE (p. 978).

Key to the Genera.

A. Length of ischium greater than width of pelvis across antitrochanter.

a. Synsacrum very wide in front of acetabulum and greatly constricted in the region of the ilio-ischiadic foramen; the ends of the sacral ribs partially filling up the ilio-ischiadic foramen; pre-ilium very long and attenuated, more than twice width across pelvis at acetabulum; ischium longer than post-ilium; pubis with the free ends directed slightly downwards .... *Aptenodytes.*

b. Synsacrum only slightly constricted in region of ilio-ischiadic foramen; ends of sacral ribs not constricting size of the ilio-ischiadic foramen; anterior end of pre-ilium with a strongly curved outer border.

a′. Length of pre-ilium twice that of width of pelvis across antitrochanter; distance from posterior border of the ilio-ischiadic foramen to the ilio-ischiadic notch at the posterior border of the innominate much greater than width of widest part of synsacrum .... *Pygoscelis.*

b′. Length of pre-ilium less than twice width of pelvis across antitrochanter; distance from posterior border of ilio-ischiadic foramen to ilio-ischiadic notch equal or nearly equal to width of widest part of synsacrum.

a″. Dorsal surface of synsacrum with the median ridge feebly developed in the acetabular region .... *Catarrhactes.*

b″. Dorsal surface of synsacrum with a strong median ridge along its whole length .... *Spheniscus.*

B. Length of ischium not exceeding width of pelvis across antitrochanter; width across pre-ilium at widest part equals that across pelvis at antitrochanter. *Eudyptes.*

Key to the Species.

CATARRHACTES.

a. Width across widest part of synsacrum—dorsal view—much greater than depth of post-ilium from dorsal to ventral border ... *C. chysolophus.*

b. Width across widest part of synsacrum equal to depth of post-ilium. { *C. chrysocome.* *C. pachyrhynchus.*

PYGOSCELIS.

a. Innominate free; median synsacral ridge not expanded in region of acetabulum .... *P. adeliæ.*

b. Innominate fused with synsacrum; median synsacral ridge expanded in acetabular region .... *P. papua.*

APTENODYTES.

a. Size larger; total length 9·7 in.; synsacrum not greatly constricted in antitrochanteric region.. *A. forsteri.*

b. Size smaller, not exceeding 8·5 in.; synsacrum much constricted in antitrochanteric region .... *A. patagonicus.*

EUDYPTULA.

a. Size larger, not exceeding 3·4 in.................................. *E. albosignata.*

b. Size smaller, not exceeding 3 in. .... *E. minor.*

SPHENISCUS.

a. Pre-ilium truncated anteriorly.................................. *S. demersus.*

b. Pre-ilium rounded anteriorly .... *S. magellanicus.*

E. PECTORAL LIMB.

All the bones much flattened dorso-ventrally; humerus with a large, non-pneumatic fossa at its proximal end, obliquely truncated distally, and grooved for large, ossified sesamoids; ulnare of great size, and more or less triangular in outline; Mc. I. fused with Mc. II., and without phalanges.

F. PELVIC LIMB.

Width across the tarso-metatarsus nearly as great as the length. Metatarsals more or less perfectly separated one from another by grooves; no ectotrochlear foramen; 2nd trochlea shorter than the 3rd, and not directed backwards.

Key to the Genera.

A. Anterior face of tarso-metatarsal region (proximal end) flattened, not scooped out so as to be overhung by the fused tarsals; interosseous metatarsal foramina large and conspicuous; of the three metatarsals the median is distinctly the shortest; entocalcaneal crest distinct; ento- and ectocnemial crests well developed and enclosing a deep gorge; ectocnemial crest directed forwards and running down shaft as far as upper third of fibular ridge; insertion of tibialis anticus marked by a slightly hollowed oval scar in upper third Met. III. .... *Aptenodytes.*

B. Anterior face of tarso-metatarsal region (proximal end) slightly depressed; interosseous metatarsal foramina small; intermetatarsal grooves shallow; of the three metatarsals the III. is the shortest; calcaneal crests obsolete; ectocnemial crest directed outwards, not continued down the shaft; ento- and ectocnemial crests do not enclose a deep gorge .... *Pygoscelis.*

C. Anterior face of tarso-metatarsus (proximal end) markedly depressed or scooped out; interosseous metatarsal foramina small.

a'. Inner intermetatarsal groove very shallow, outer deep; ectocnemial crest small, directed outwards; ecto- and entocnemial crests not enclosing a deep gorge as in *Aptenodytes*; ecto- and entocalcaneal crests moderately developed .... *Catarrhactes*.

b'. Inner and outer intermetatarsal grooves deep and long; inner and middle metatarsals laterally compressed, with a distinct tubercle for the tibialis anticus; ento- and ectocnemial crests enclosing a deep but short gorge .... *Spheniscus*.

c'. Intermetatarsal grooves distinct; ento- and ectocnemial crests slightly developed, enclosing a narrow and not very deep gorge.. *Eudyptes*.

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EXPLANATION OF THE PLATES.

Plate LIX.

c.p.=cerebellar prominence, dome.
c.r.=coronal ridge.
l.=lachrymal.
n.=nasal.
n. pmx.=nasal process of premaxilla.
p.=palatine.
s.c.=sagittal crest.
sq.p.r.=squamoso-parietal ridge.
t.f.=temporal fossa.

The Dorsal Aspect of the Skull.

Fig. 1. The skull of *Spheniscus magellanicus* Forst., to show the great size of the temporal fossa and of the squamoso-parietal wings; the sagittal crest, coronal ridge, and the slight development of the supra-orbital ledge.

Fig. 2. The skull of *Pygoscelis papua* Forst., to show the great development of the supra-orbital ledge, the free nasal processes of the premaxilla, the form of the temporal fossa, and the lachrymal.

Fig. 3. The skull of *Aptenodytes patagonica* Forst., to show the supra-orbital ledge, the free nasal processes of the nasal processes of the premaxilla, the shallow temporal fossa, and great width at the transverse lambdoidal ridge.

Fig. 4. The skull of *Eudyptula albosignata* Finsch, showing the almost complete absence of a supra-orbital ledge and the form of the temporal fossa.

Fig. 5. The skull of *Catarrhactes chrysocome* Forst., to show the form of the supra-orbital ledge and of the temporal fossa.

Plate LX.

a.=angulare.
a.o.p.=antorbital plate.
c.p.=cerebellar prominence.
d.s.=dentary suture.
i.o.s.=interorbital septum.
l.=lachrymal.
p.=palatine.
p.o.p.=postorbital process.
p.p.=paroccipital process.
pmx.=premaxilla.
pt.=pterygoid.
q=quadrate.
v=vomer.

The Lateral Aspect of the Skull.

Fig. 1. The skull of *Eudyptula albosignata* Finsch, to show the temporal fossa, the slightly curved quadrato-jugal bar, and the dentary suture of the mandible.

Fig. 2. The skull of *Catarrhactes chrysocome* Forst., to show the temporal fossa, the size of the squamoso-parietal wings, the great curvature of the quadrato-jugal bar and of the dentary suture of the mandible.

Fig. 3. The skull of *Megadyptes antipodum* Homb. & Jacq., for comparison with that of *Catarrhactes*, to show the greater size of the temporal fossa and squamoso-parietal wings and the more slender jaws.

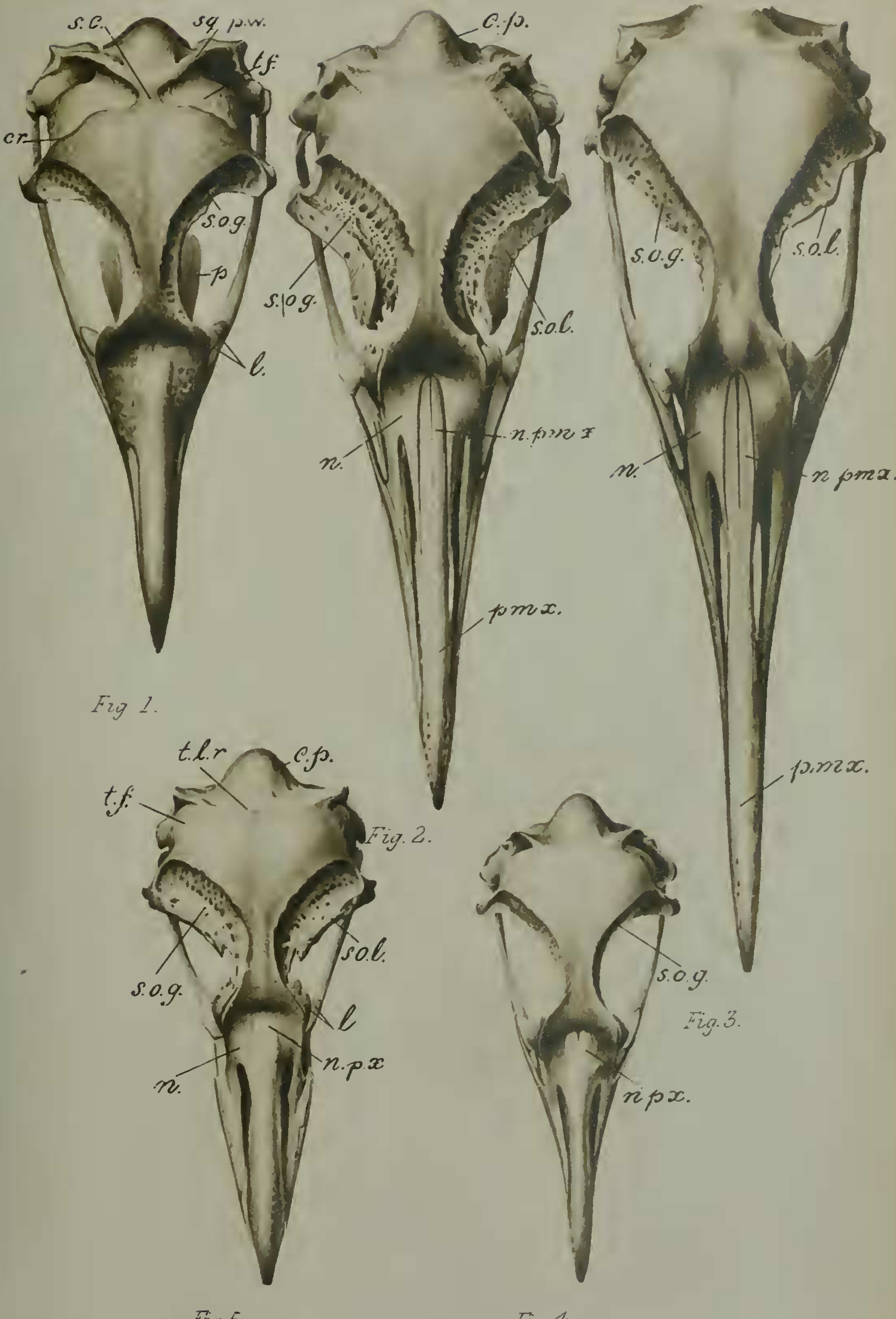
Plate LXI.

Additional letters.

als.=alisphenoid.
ang.=angulare.
ar.=articulare.
ant.b.f.=anterior basicranial fontanelle.
b.oc.=basioccipital.
bt.pl.=basitemporal plate.
b.s.=basisphenoid.
cor.=coronoid.
d.=dentary.
ep.o.=epiotic.
ex.=exoccipital.
fr.=frontal.
h.pt.=hemipterygoid.
j.=jugal.
max.=maxilla.
mes.=mesethmoid.
op.=opisthotic.
p.=parietal.
par.=parasphenoid.
pro.=proötic.
s.a.=supra-angular.
s.o.=supra-occipital.
sp.=splenial.
sq.=squamosal.
v.=vomer.

The Skull of the Nestling.

Fig. 1. Inner view of a longitudinal section of the skull of a nestling *Catarrhactes chrysocome*, showing the unclosed sutures.



OSTEOLOGY OF THE IMPENNES

Fig. 1. *Spheniscus magellanicus.* Fig. 2. *Pygoscelis papua.* Fig. 3. *Aptenodytes, patagonica.* Fig. 4. *Eudyptula albosignata* Fig. 5 *Catarrhactes chrysocome.*

...önvold del. Photoprint by Bale & Danielsson Ld